media) from India, three Red Deer (*Cervus elaphus* ♂ ♀ ♀), British, two White-tailed Gnus (*Connochætes gnu* ♂ ♀), bred in Holland; a Ruffed Lemur (*Lemur varius*) from Madagascar, deposited; a Red-crested Pochard (*Fuligula rufina* ♂) from India, purchased.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 *NOVEMBER* 4-10.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 4

Sun rises, 7h. 2m.; souths, 11h. 43m. 40·9s.; sets, 16h. 26m.: right asc. on meridian, 14h. 40·3m.; decl. 15° 36′ S. Sidereal Time at Sunset, 19h. 23m.

Moon (New on November 4, 0h., and at First Quarter November 10, 16h.) rises, 7h. 13m.; souths, 12h. 18m.; sets, 17h. 12m.: right asc. on meridian, 15h. 14·5m.; decl. 13° 20′ S.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.	
	h. m.	h. m.	h. m.	h. m.	° ′
Mercury..	6 16	11 15	16 14	14 11·2	12 29 S.
Venus ...	9 54	13 47	17 40	16 44·3	23 28 S.
Mars ...	12 0	15 43	19 26	18 40·0	24 41 S.
Jupiter ...	9 30	13 36	17 42	16 32·6	21 27 S.
Saturn ...	23 7*	6 34	14 1	9 29·6	15 45 N.
Uranus ...	4 47	10 15	15 43	13 11·7	6 57 S.
Neptune..	17 19*	1 4	8 49	3 58·7	18 46 N.

* Indicates that the rising is that of the preceding evening.

Occultation of Star by the Moon (visible at Greenwich).

Nov.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
6	B.A.C. 5954	6	18 13	18 57	75 348

Nov.	h.	
5	19	Jupiter in conjunction with and 3° 5′ south of the Moon.
6	3	Venus in conjunction with and 4° 28′ south of the Moon.
6	22	Mercury at least distance from the Sun.
8	0	Mars in conjunction with and 2° 35′ south of the Moon.
9	18	Mercury stationary.

Saturn, November 4.—Outer major axis of outer ring = 40″·7: outer minor axis of outer ring = 9″·7: southern surface visible.

Variable Stars.

Star.	R.A.	Decl.			
	h. m.	° ′		h. m.	
U Cephei	0 52·4	81 16 N.	Nov. 5,	1 49	*m*
			,, 10,	1 28	*m*
λ Tauri...	3 54·5	12 10 N.	,, 7,	2 23	*m*
T Monocerotis ...	6 19·2	7 9 N.	,, 6,	5 0	*m*
R Canis Majoris...	7 14·5	16 12 N.	,, 8,	23 42	*m*
			,, 10,	2 58	*m*
R Ursæ Majoris ...	10 36·7	69 22 N.	,, 7,		*M*
S Ophiuchi	16 27·8	16 55 S.	,, 9,		*M*
U Ophiuchi... ...	17 10·9	1 20 N.	,, 6,	18 58	*m*
W Sagittarii ...	17 57·9	29 35 S.	,, 7,	19 0	*m*
β Lyræ...	18 46·0	33 14 N.	,, 5,	2 0	*m*
S Vulpeculæ ...	19 43·8	27 1 N.	,, 8,		*M*
S Sagittæ	19 50·9	16 20 N.	,, 8,	19 0	*m*
T Vulpeculæ ...	20 46·7	27 50 N.	,, 8,	6 0	*m*
Y Cygni	20 47·6	34 14 N.	,, 4,	3 0	*m*
			,, 7,	3 0	*m*
W Cygni	21 31·8	44 53 N.	,, 10,		*m*
δ Cephei	22 25·0	57 51 N.	,, 9,	1 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near γ Camelopardalis...	54°	71° N.	Swift.
The *Taurids*	60	20 N.	Slow; bright.
	350	52 N.	Rather slow.

GEOGRAPHICAL NOTES.

In some notes embodying the results of his own observations, contributed to the *Mittheilungen* of the Hamburg Geographical Society, Dr. H. Lindemann throws some light on the physical geography of the interior of Heligoland. He points out that the island is protected on the east from the action of the sea by a long and narrow sand-dune, about 1¼ mile distant. The gradual disappearance of this British possession, Dr. Lindemann points out, is but partly due to the action of the sea. This is especially the case with the western side, where the strength of the waves is much greater. The chief factors in wearing down the island are the heavy rainfall, the variations in the weather, and the dissolving power of the frost; all these causes effect the disintegration of the stones and the denudation of the land. The results can be seen better at work on the eastern side of the island, for the strata and the inclination of the Oberland are towards the north-east, and all the water consequently flows that way. The eastern side is largely planted with potatoes, and the gradual disappearance of these potato-fields gives us a tolerably good basis on which to calculate the sinking of this side of the island. There is now nothing remaining of a potato-field which only eighty years ago measured 80 metres, and another field, 25 metres broad, has been reduced within the same period to 3 metres. In old maps we find an ancient cemetery on the eastern side of the Oberland, which had to be removed to its present position. These causes, but, above all, the direction in which the strata lie, produce the different aspect of the eastern and western sides. The eastern cliff is mostly uniform and perpendicular; the western side offers a splendid and varied example of the invasive powers of the sea, with its many inlets, caverns, and chiselled pillars now separated from the main rock. From a comparison with the measurements taken in 1845, Lindemann finds that the western cliff had receded about 7 feet in the last forty years, or at the rate of about 2 inches a year. The Unterland was joined to the dune by a stone jetty, called the Waal, as recently as the seventeenth century. This Waal formed a kind of semicircular harbour, open on the north and south sides. If we take Geern's map, we find the place of the old northern harbour occupied then by green pastures and meadows. But this has all been swept away; the sea carried most of the jetty towards the Unterland and the dune. The destruction of the breakwater had the effect upon the mainland that the Unterland, against which the masses of stone were driven, was gradually so greatly increased that new rows of houses could be built upon the beach.

It is stated that contracts have been entered into in America for the construction of two steamers intended for an expedition to the Antarctic regions, which is being organized by Mr. Henry Villard. The officers and scientific staff of the expedition will all be Americans and Germans, as the enterprise is stated to be in great part supported by Hamburg money. The expedition will start from New York, and its object will be mainly the exploration of the South Shetlands, South Orkneys, South Georgia, and the Poovel Islands. This expedition seems to be independent of that to be sent out by the German Government under the conduct of Dr. Neumayer.

Mr. Joseph Thomson has returned from Morocco in compliance with an urgent telegram from the British East African Company. Mr. Thomson will probably start immediately for Mombassa, and we have reason to believe will be intrusted with a very important mission to the interior.

PRELIMINARY NOTE ON THE ANATOMY AND PHYSIOLOGY OF PROTOPTERUS ANNECTENS.

Introduction.

Owing to the generosity of Prof. Wiedersheim, I have recently had the opportunity of making some observations on the structure and mode of life of *Protopterus.* Although I can at present only give a few brief notes on the subject, some points have already proved so interesting, that it has seemed worth while to give an abstract of my results up to the present time, leaving a detailed description until a later date.

I was fortunate enough to be present in Freiburg at the end of last June when a quantity of fresh material arrived. This was procured direct from the Gambia, owing, in the first instance, to the energy of Dr. J. Beard, who, assisted by a grant from the Royal Society, hoped by procuring Protopterus in sufficient numbers, and keeping them alive under suitable conditions, to be able to study their development. My thanks are therefore due to Dr. Beard, as well as to Prof. Wiedersheim, for the specimens I have made use of.

The clods of earth in which the animals were inclosed in their torpid state having been opened up, they were found to contain about one hundred living specimens, varying in length from about 8 to 80 cm. These were kept in a tank in the Botanical Garden, in water which stood at a temperature of 18° Réaumur. They were fed with water-snails, earth-worms, Entomostraca, and small fishes, the last of which they seemed to prefer. But the abundant nourishment with which they were supplied did not prevent them from killing one another, so that at the date of writing only a small proportion still remain alive. In order to prevent this cannibalism, we should have isolated them by means of wire-netting, had it not been thought that this would greatly lessen any chance of obtaining embryos. Their vitality is very remarkable: after having been bitten severely, and having consequently lost much blood, they will usually live for some days.

The structure of the "cocoon," and the position of the animal within it, have already been described by Wiedersheim,[1] and in this connection I have only one point to add with regard to the respiration of Protopterus during its torpid state. Although in one or two of the specimens we noticed a slight redness of the tail, I doubt very much whether, as Wiedersheim supposed, the tail serves as a respiratory organ during this period. A close examination of that part of the cocoon-membrane which closes the bottom of the earth-tube, and which overlies the animal's nose, showed that no additional respiratory apparatus was necessary. Looking at this membrane from the outer side, the small aperture described by Bartlett and Krauss can be plainly seen. On the inner side, the rim of this aperture is produced into a funnel-shaped tube, the free end of which lies between the lips of the animal. Consequently, by means of this pipe, the Protopterus can inhale and exhale air during its long sleep. On being removed from the cocoon, moreover, the lungs were always found to be greatly distended and full of air, bubbles of which were immediately given off into the tank in which the specimens were placed. In all probability the above-mentioned tube is produced by suction, when the secretion which gives rise to the cocoon is still soft. The curious squeak which Protopterus makes when set free from the cocoon has been noticed by other observers.

In addition to dissections, and sections of various individual parts, I have made a complete series of transverse sections—in all about 2100—of a small female specimen: these are extremely instructive.

Integument.—Each outer cell of the epidermis is provided with a cuticular cap, and the whole of the epidermis is closely packed with goblet cells, which are less numerous on the paired fins than on the body, where they are less than the diameter of a single one apart. Multicellular glands, very simular to those of Amphibia, are also present here and there throughout the body, and are particularly numerous on the snout. Nests of lymphatic tissue are present beneath the epidermis in some regions.

Muscles.—The chief point of interest I wish to mention concerning the muscles is that they, more particularly the great lateral muscles of the tail, serve as stores of nutriment for the animal during its torpid state. A similar phenomenon has been described by Miescher-Rüsch in the salmon during the spawning season.[2]

The muscular tissue in places shows histologically all stages of retrogressive metamorphosis, and owing to this process, the leucocytes are able to absorb its broken-down remnants, which can be plainly recognized within many of the leucocytes which simply swarm into the muscles in these regions. In some parts the muscle is completely eaten away, so that nothing but the perimysium is left.

Nervous System.—An account of the structure of the nerves, with their numerous spindle-shaped nuclei, and of the remarkable nerve-cells, I cannot give here, and I also reserve at present a description of certain of the cranial and spinal nerves, and of the nerve-supply of the fins. I must, however, mention that the pulmonary nerve crosses its fellow at the base of the lungs, and then runs along the dorsal surface of the lung of the other side. A lateral nerve is situated on either side of the notochord, beneath the muscles, at the point where the dorso-lateral and ventro-lateral muscles meet. The spinal ganglia lie outside the canal. No trace of a sympathetic could be detected.

SENSORY ORGANS.—*Integumentary Sense-organs.*—These are very numerous in the head, and in the body they are not restricted to the main lateral line, but are present in regions above and below it also. They are situated within the epidermis, external to the scales. The moisture necessary for their persistence during the torpid period is produced by the gland-cells of the integument. A mass of lymphatic tissue is usually present directly beneath each: this may be concerned with its nutriment, for it is known that in Amphibians these organs are continually undergoing regeneration. I have been unable to discover any sensory organs in the integument of the paired fins, and the function of these curious filamentous appendages, with their large nerve-supply, is still problematical.

The pharynx is provided with sensory organs similar in structure to those of the integument.

Olfactory Organ.—The structure of the nose is very complicated. In the presence of accessory cavities, it resembles that of Amphibia, but in the folding of the epithelium it is more similar to that of fishes. The main cavity gives rise to dorsal and lateral extensions, the latter corresponding closely with the "pars maxillaris" of Amphibia. Posteriorly, the main cavity branches into a number of tubes, each with a small lumen; these in transverse section resemble gland-tubes cut across. The olfactory cells are in some parts diffuse, in others arranged in groups, as in many fishes and Amphibians.

No special glands are present in connection with the nose, as one would naturally expect. But the moisture necessary for the olfactory cells is probably produced by the numerous goblet cells which are present in the epithelium of the mouth and that lining the anterior and posterior narial passages. This may explain the peculiar position of the anterior nostrils, which open beneath the upper lip.

Eye.—No gland is present within the orbit. The lens is globular and relatively large, filling up the greater part of the posterior chamber, so that there is little space left for the vitreous body. The sclerotic is fibrous, but a few cartilage cells can be recognized in those regions in which the eye-muscles are inserted. The choroid is rudimentary, and contains no pigment, and there is no iris or pupil, the pupillary membrane being continuous over the front of the lens. The epidermis thins out slightly over the eye, and in this region the goblet cells are smaller and less numerous. The dermal fibres are directly continued on the one hand into the representative of the cornea, and on the other into the sclerotic. Processes of the pigment cells of the retina can be seen passing between the rods and cones. No trace of a processus falciformis could be seen.

ALIMENTARY CANAL.—*Lips.*—No muscles are present in connection with the lips, as is stated to be the case by Ayers.[1] Beneath the epidermis they consist of a curious embryonic connective tissue very rich in nuclei, similar to that found in the snout and tongue.

Tongue.—The tongue is covered with numerous filiform papillæ in older specimens, the histological structure of which I have not yet examined. None are present, however, in the sections of a younger specimen. Goblet cells are very numerous in the epithelium, which is folded so as to give rise to a number of simple gland-like sacs. No sense-organs can be seen in my sections. The extrinsic muscles are, on either side, (1) a large hyoglossus, and (2) a small band-like branchioglossus. There are no intrinsic muscles, the whole of the substance of the anterior part of the tongue beneath the epithelium consisting of the connective-tissue referred to above.

On the floor of the mouth, in front of the tongue, and between the two cusps of the mandibular teeth, is a curious tube-like epithelial organ which apparently opens by a small aperture near its posterior end into a median groove of the oral epithelium. This tube is lined by columnar epithelium with goblet cells.

Thyroid.—The thyroid is a small bilobed organ, situated between the connective-tissue and muscular portions of the tongue. Its epithelium is flat, and the tubules contain a colloid mass which stains deeply.

Thymus.—The well-developed thymus consists of adenoid connective-tissue with leucocytes, and lies on the dorsal side of the gill-arches. Black pigment is present in the anterior part of its inner portion.

---

[1] *Anat. Anzeiger*, II. Jahrgang, 1887; and Proc. Brit. Assoc., 1887.

[2] "Ueber das Leben des Rheinlachses im Süsswasser," *Archiv. f. Anat. u. Physiol.*, 1881.

[1] "Beiträge z. Anat. u. Physiol. der Dipnoër," *Jen. Zeitschr. f. Naturwiss.*, Bd. 18, 1885.

Epithelium.—The epithelium lining the mouth consists of polygonal cells, apparently without cilia. In the pharynx, nests of simple glands, like those of the tongue, are present; and, as already mentioned, numerous sense-organs are to be found in the region of the gill-clefts. The epithelial cells of the stomach and intestine are columnar, but vary much in their form and proportions. Cilia could be detected here and there; in all probability they occur in isolated regions, as in the adult lamprey.

With the exception of the large liver, there is no trace of any gland in connection with the stomach and intestine, and digestion must be thus performed largely through the instrumentality of leucocytes.

Muscles of the Alimentary Canal.—The muscles of the walls of both stomach and intestine are only very slightly developed in torpid specimens, and are apparently broken up and separated by the lymphatic tissue to be described presently. They probably, therefore, undergo a similar degeneration to that observed in the caudal muscles.

Lymphatic Organs of the Stomach and Intestine.—The form of these organs has been described by Ayers (*loc. cit.*) I have not been able to verify his supposition that there are direct connections between them and the lumen of the intestine. A central part of the lymphatic organ running down the axis of the spiral valve can be distinguished from the rest by its more compact structure. Many of the leucocytes in these regions are full of fat-globules.

A large lymphatic body is present behind the cloaca and pelvis, and probably serves to protect the vent from the entrance of harmful substances.

Cloacal Cæcum.—The so-called "urinary bladder" opens into the cloaca between the rectum and the urinary and generative ducts. It has therefore much the position of the "rectal gland" of Selachians, and probably has nothing to do with the urinary bladder of other forms.

Lungs.—The cavity of the lungs is divided up by trabeculæ, which give the anterior unpaired portion a sponge-like appearance: a central lumen is present in the paired portion. A large lymphatic organ lies beneath the anterior unpaired part, the curious relations of which I hope to describe later, and will now only mention that the blood corpuscles migrate from it into the tissues of the lung.

Abdominal Pores.—As Ayers has shown, only one abdominal pore is usually present, and in my sections this ends blindly, and does not open into the cœlome. Probably its relations vary in different individuals.

Blood Corpuscles.—The chief peculiarity of the blood of Protopterus is the large size of the corpuscles, and the comparatively large proportion of the white in comparison with the red. The form of the latter resembles that of the red corpuscles of Amphibians. In length they measure from 0·040–0·046 mm., and in width 0·025–0·027 mm. The size of the white corpuscles varies greatly. The diameter of the largest, when not throwing out pseudopodia, may exceed the length of a red corpuscle. Two kinds may be distinguished, as follows:—(1) Large leucocytes of the ordinary form, the protoplasm of which is usually distinctly differentiated into a coarsely granular endoplasm and a hyaline ectoplasm. In specimens prepared for me by Dr. Goldmann, according to Dr. Ehrlich's method, the protoplasm and nucleus are coloured violet. (2) Leucocytes of various sizes, the largest being usually rather smaller than those described above. The granules in the protoplasm are finer, and in addition to the ordinary blunt pseudopodia, stiff filamentous processes are also formed. The protoplasm of these stains brownish-red by Ehrlich's method, and Dr. Goldmann informs me that a similar coloration occurs in human white corpuscles in cases of leukæmia. Prof. August Gruber was kind enough to make a careful examination of these corpuscles with me, and we were able to trace a gradual disintegration in those described under (2), until finally nothing but the greatly altered nucleus is left. It seems probable, therefore, that these leucocytes convey the nutriment from the alimentary canal (or muscles) into the blood, and there disintegrate.

Blood-vessels.—I have at present only one or two remarks to make on the arrangement of the blood-vessels. Hyrtl's description [1] of the vessels of Lepidosiren would answer equally well in most points to Protopterus. Peters [2] describes a single pulmonary artery, arising from the efferent branchial vessels on the left side. This soon branches into two, each branch running along the inner side of the corresponding lung. No mention, however, is made by Peters of the corresponding right vessel, which has precisely the arrangement described by Hyrtl in Lepidosiren. This right pulmonary artery also divides into two, one branch passing along the dorsal surface of each lung alongside the pulmonary branch of the vagus.

The caudal vein divides up into two renal-portals. These are said by Hyrtl to anastomose anteriorly with a paired azygos in Lepidosiren. I have been unable to find any such "azygos vein" in Protopterus. The two so-called "venæ cavæ posteriores" doubtless correspond to the posterior cardinals, though they are somewhat modified. No lymphatic vessels could be detected.

Urinary Organs.—The kidneys are closely invested everywhere except on their dorsal side, by lymphoid and fatty tissue, which posteriorly forms a large median mass, plugging the end of the cœlome. No nephrostomes are present, as was supposed by Ayers.

A quantity of pigmented tissue on the outer and lower borders of the kidneys may possibly represent the adrenals.

Generative Organs.—Concerning the structure of the female generative organs, I have, as yet, little to add to the descriptions of former observers. No accurate account of the male organs exists, and I am inclined to think that the descriptions which have been given up to the present time referred to immature females, the generative organs of which might easily be taken for those of a male.

I have been able to distinguish no essential differences in external form between males and females: the latter are by far the more abundant.

Each testis has much the form and relations of an immature ovary, and, like the ovary, is invested along its free edge and sides with lymphatic and fatty tissue. Along its ventral surface a slight groove can be distinguished, at the bottom of which the spermatic duct lies. Posteriorly, the two ducts come to the surface, unite, and open by a common aperture on a papilla into the cloaca, just as in the female. In transverse sections, the seminiferous tubules can be seen opening into the ducts; in ripe specimens, fully formed spermatozoa can be seen in their lumina. I have, up to the present time, found nothing which could correspond to the remnant of a Müllerian duct, and, as the ureter undoubtedly must represent the mesonephric duct, there remains no other explanation of the duct of the testis than to suppose it to be the homologue of the Müllerian duct.

The form of the spermatozoa is very curious: they are carrot-shaped, and each is provided with two long cilia. They are very small, the length of the carrot-shaped head being only about 1/25 mm.

Most of the above observations were made in the Anatomical Institute in Freiburg i/B, where I have profited much by the kind help and advice of Prof. Wiedersheim.

August 31, 1888. W. Newton Parker.

A more detailed examination of a male specimen, in which the spermatozoa were not yet ripe, has shown that distinct rudiments of the anterior parts of the Müllerian ducts are present. Each has an abdominal aperture, similar in form and position to that of the oviduct, and extends backwards for a short distance, tapering off before the level of the kidneys is reached. In sexually mature individuals, all traces of the Müllerian ducts appear to have vanished.

The duct of the kidney must therefore, as in Elasmobranchs, represent a special collecting-tube developed in connection with the posterior mesonephric tubules. W. N. P.

University College, Cardiff, October 27.

THE WHEAT CROP OF 1888.

SIR JOHN LAWES has communicated some interesting facts with regard to the wheat crop of the present year. It has been Sir John Lawes's endeavour for many years past to establish a statistical relation between the fluctuations of the yield of wheat upon his own well-known experimental field in Hertfordshire with the general average obtained over the United Kingdom. In order to do this he has selected certain plots and taken their average yields, and it is maintained that the result so obtained fairly represents the average yield over the United Kingdom.

---

[1] *Abhandlungen d. böhm. Gesell. d. Wiss.*, 1845.

[2] *Müll. Arch. f. Anat.*, 1845.